European Journal of Vascular and Endovascular Surgery 43 (2012) 38–42

Contents lists available at SciVerse ScienceDirect

European Journal of Vascular and Endovascular Surgery

journal homepage: www.ejves.com

Laparoscopic Surgery for Coeliac Artery Compression Syndrome: Current Management and Technical Aspects

X. Berard [a,*], J. Cau [b], S. Déglise [c], D. Trombert [a], B. Saint-Lebes [c], D. Midy [a], J.M. Corpataux [c], J.B. Ricco [b]

[a] Department of Vascular Surgery, University Hospital of Bordeaux, Tripode-Pellegrin, Place Amelie Raba Leon, 33000 Bordeaux, France
[b] Department of Vascular Surgery, University Hospital of Poitiers, France
[c] Department of Vascular Surgery, University Hospital of Lausanne, Switzerland

WHAT THIS PAPER ADDS

- This article describes two laparoscopic approaches to treat coeliac artery compression syndrome. The tips and tricks to obtain a better exposure and a safer procedure are also discussed. The outcomes are analysed in the light of management of restenosis following laparoscopic release and optimal workout to select the best candidate for this surgery.

ARTICLE INFO

Article history:
Received 11 July 2011
Accepted 16 September 2011
Available online 15 October 2011

Keywords:
Trans-peritoneal laparoscopy
Coeliac artery compression syndrome
Residual stenosis
Median arcuate ligament syndrome
Chart review

ABSTRACT

Objectives: The study aims to assess the feasibility and midterm outcome of trans-peritoneal laparoscopy for coeliac artery compression syndrome (CACS).
Design: Retrospective chart review involving four European vascular surgery departments and two surgical teams.
Materials and methods: charts for patients who underwent laparoscopy for symptomatic CACS between December 2003 and November 2009 were reviewed. Preoperative computed tomography (CT) angiography and postoperative duplex scan and/or CT angiography were performed.
Results: Eleven consecutive patients (nine women) with a median age of 52 years (interquartile range: 42.5–59 years) underwent trans-peritoneal laparoscopy for CACS. All patients had a history of postprandial abdominal pain; weight loss exceeded 10% of the body mass in eight cases. Preoperative CT angiography revealed coeliac trunk stenosis >70% in all cases. One patient had additional aortitis and inferior mesenteric artery occlusion, while another patient presented with an occluded superior mesenteric artery. Two conversions occurred (one difficult dissection and one aorto-hepatic bypass needed for incomplete release of CACS). The median blood loss was 195 ml (range: 50–900 ml) and median operative time was 80 min (interquartile range: 65–162.5 years). Symptoms improved immediately in 10/11 patients (no residual stenosis) while one remained unchanged despite a residual stenosis treated by a percutaneous angioplasty. Symptoms reappeared in one patient due to coeliac axis occlusion. The mean follow-up period was 35 ± 23 months (range: 12–78 months).
Conclusion: Our study demonstrates that trans-peritoneal laparoscopy for treating median arcuate ligament syndrome is safe and feasible. Additional patients and a longer follow-up are needed for long-term assessment of this laparoscopic technique.

In 1917, during cadaveric dissection, Lipshutz[1] observed that the coeliac artery was occasionally constricted by excessive fibres arising from the diaphragm. Almost 50 years later, Harjola[2] and Dumbar[3] linked this anatomic anomaly with digestive symptoms and described the median arcuate ligament (MAL) syndrome, also known as the coeliac artery compression syndrome (CACS). However, among all vascular entrapment syndromes,[4] CACS remains one of the most debated vascular diseases due to its non-elucidated pathophysiologic mechanism. Indeed, the abundant collateral circulation should in general be able to compensate for a single vessel abdominal arterial stenosis. Even today, surgical decompression of the coeliac axis (CA) by division of the MAL is preferred to endovascular treatment.[5] Recently, studies have clarified the appropriate preoperative investigations to select the candidates who could benefit most from this release,[6] and several

* Corresponding author. Tel.: +33 5 56 79 61 77; fax: +33 5 56 79 61 05.
E-mail address: xavier.berard@chu-bordeaux.fr (X. Berard).

1078-5884/$ – see front matter © 2011 European Society for Vascular Surgery. Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.ejvs.2011.09.023

case series[7–10] have shown promising results using a laparoscopic technique. The present study describes and evaluates the feasibility and the medium-term outcome of the trans-peritoneal laparoscopic approach to divide the MAL. Based on our experience and a review of the literature, we will also discuss the optimal management of this controversial pathology.

Material and Methods

Study population. The charts of patients who were operated on between December 2003 and November 2009 for symptomatic CACS using a laparoscopic approach at four European vascular departments (Bordeaux University Hospital France, Poitiers University Hospital France, Toulouse University Hospital France and Lausanne University Hospital Switzerland) were reviewed. Demographic data, clinical presentation, surgical technique including procedural details and follow-up for all patients were retrospectively recorded in a computer database. Informed consent was obtained from all patients.

Preoperative assessment. Suffering from various digestive symptoms, such as abdominal pain, weight loss, bloating or vomiting, all patients were first referred by their family physician to a gastroenterologist. The latter conducted at least a gastric endoscopy that was normal and, suspecting gastrointestinal ischaemia, requested a Duplex ultrasound (US) with inspiration/expiration manoeuvres and a computed tomographic angiography (CTA). This exam revealed coeliac trunk stenosis >70% in all cases. In one patient, aortitis and inferior mesenteric artery occlusion were also found. In another case, the superior mesenteric artery was occluded. Those patients with coeliac artery stenosis and no other abdominal abnormalities at CTA and/or a peak velocity >200 cm s^{-1} in the coeliac artery at US were then referred to a vascular surgeon for a suspicion of CACS. Based on findings of an eccentric non-calcified stenosis at the coeliac trunk at basal and three-dimensional (3D reconstruction) CTA, the presence of signs of gastrointestinal ischaemia and no other possible cause of pain, the surgeon planned a laparoscopic release of the MAL.

Operative techniques. All procedures were carried out under general anaesthesia. On the operating table, patients were placed in a supine split-leg position with a steep reverse Trendelenburg position. Five ports were typically placed (Fig. 1). An optical 10-mm trocar was used to enter the abdomen midway between the xyphoid and the umbilicus. After first insufflating the abdomen to 12 mmHg with carbon dioxide, three additional 5-mm working trocars were placed using videoscopic guidance from a 30°-angled camera. A fan retractor was inserted through a 10-mm subxyphoid port and used to retract the left lobe of the liver laterally. The technical approach was done using an antegrade or a retrograde dissection from the aorta to the MAL.

The antegrade dissection (performed by XB) consisted of the following steps: the avascular region of the gastrohepatic omentum was divided, and the right crus of the diaphragm was identified inferiorly to the cardia. To gain a better exposure of the aortocoeliac region, the stomach was retracted to the left by a grasper introduced through the 5-mm port in the left flank (Fig. 1). The dissection was conducted posteriorly to the oesophagus, and the muscular fibres of the crural decussation were identified and then divided with a coagulating hook to expose the anterior surface of the aorta (Fig. 2). The coeliac trunk/trifurcation was visualised based on its post-stenotic dilation and pulsations. Gentle caudal retraction of this trunk/trifurcation using the laparoscopic aspirator placed on the incisura of the stomach was of great help in revealing the MAL. The ligament was first cut with the coagulating hook along with the nervous coeliac plexus and lymphatic tissue, but the final release of its fibrous component was completed using scissors

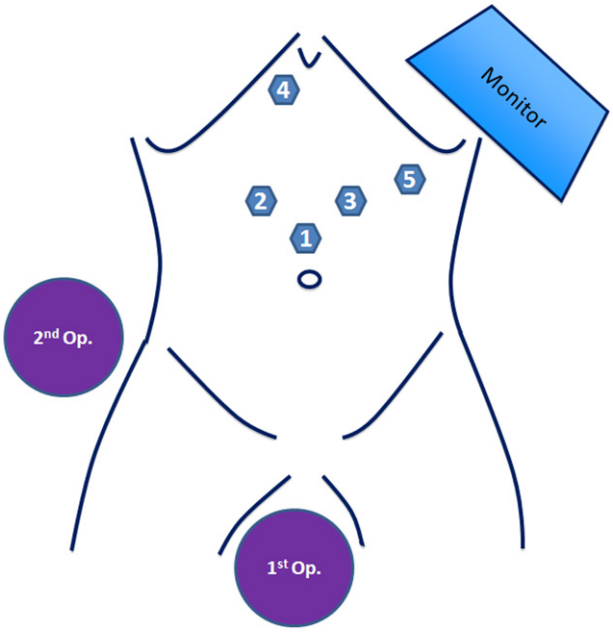

Figure 1. Trocars placement: 1:10 mm optic>30°; 2 and 3: 5 mm for left (grasper) and right (cissors/coagulating hook) hands of the first operator; 4: 10 mm for fan retractor; 5: 5 mm for second operator's grasper/aspirator; Op: operator.

within the aortic adventitia (Fig. 3). The procedure ended when the origin of the CA was freed of any external stricture.

Supplementary video related to this article can be found at doi: 10.1016/j.ejvs.2011.09.023.

The retrograde dissection (performed by JC) differed from the preceding description by the following steps: the avascular region of the gastrohepatic omentum was opened and the common hepatic artery identified. Using a coagulating hook, the dissection then followed the artery back to the trifurcation of the coeliac trunk until the MAL was encountered. The section of the MAL was carried out using a coagulating hook, which permitted elevation of the fibres from the aortic wall as they divide. In most cases, the

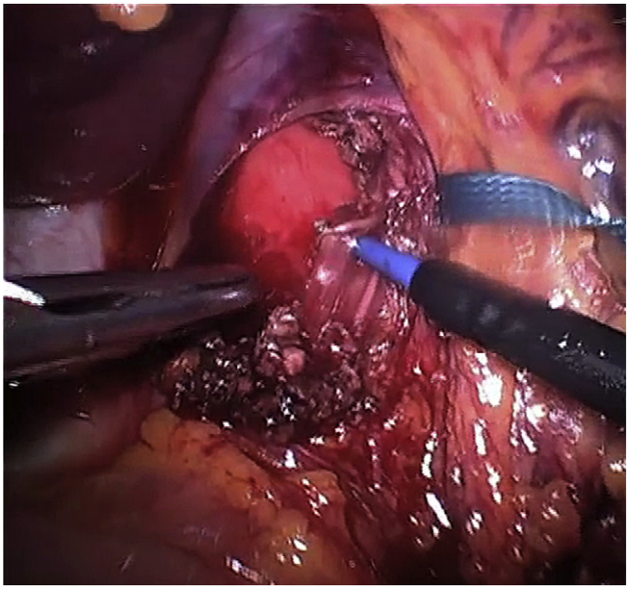

Figure 2. After retraction of the oesophagus, the section of the muscular fibres of the crural decussation with a coagulating hook exposed the anterior surface of the aorta. Then, the celiac trunk can be clearly visualized.

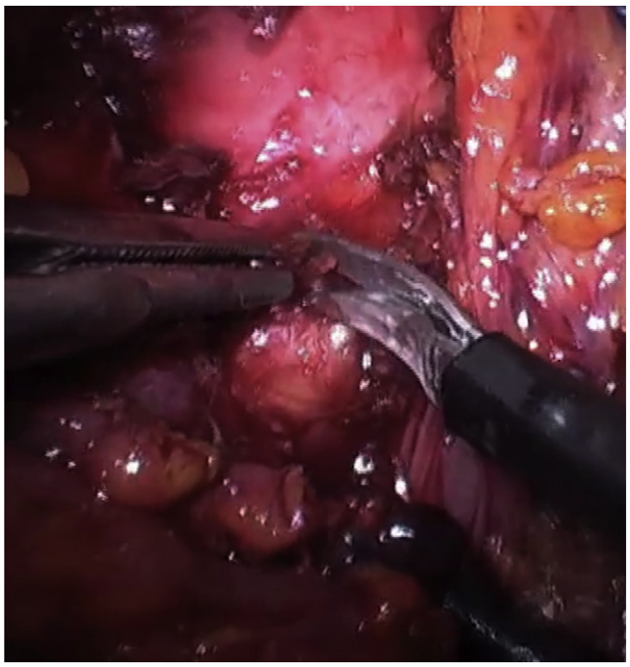

Figure 3. After exposure of the aorta and the celiac trunk with the hook, the complete release of the fibrous component of the ligament was ended using scissors within the aortic adventitia, permitting more precision than the hook.

diaphragmatic arteries were clipped to allow comfortable exposure of the aortic wall surrounding the origin of the CA.

If visual inspection indicated incomplete decompression of the CA, an intra-operative Doppler echography was performed and/or a pressure gradient measurement was achieved through a 10-mm trocar: A 18-gauge needle connected to a pressure line was placed in the coeliac trunk or in the hepatic artery and in the supracoeliac aorta. A drain was placed in 8/11 cases near the coeliac trunk through a portal skin incision for the first 24 h, and the wounds were closed in a routine fashion. All patients were extubated at the end of the procedure and discharged to the surgical ward.

Postoperative follow-up. All patients were followed by their treating surgeon at least twice a year for assessment of their clinical status and with a colour Doppler ultrasound scanning of the splanchnic arteries. Further assessment using digital subtraction angiography or CTA was carried out in patients with worsening clinical symptoms or abnormal physical and/or ultrasound findings. Decision for re-intervention was made by the attending surgeon.

Definitions and statistical analysis. Postoperative symptoms were scored as: free of symptoms, improvement or persistent symptoms. Demographic and peri-procedural characteristics are shown as number (%), mean ± SD or median with interquartile range.

Results

Patient characteristics. Between December 2003 and November 2009, 11 patients (nine women) with a median age of 52 years (interquartile range: 42.5–59.0 years) were operated for MAL using a laparoscopic approach. All patients had a history of postprandial abdominal pain, sometimes associated with bloating, vomiting or with an abdominal bruit. Weight loss exceeded 10% of the body mass in eight cases. The mean body mass index was 21.1 kg m^{-2} (range: 15.0–26.5 kg m^{-2}). Detailed clinical characteristics of the patients are summarised in Table 1.

Intervention. The median blood loss was 195 ml (range: 50–900 ml) (data not shown) and median operative time was 80 min (interquartile range: 65–162.5 min). Six patients were operated using the retrograde technique and five following the antegrade technique. Using the retrograde technique, two patients required conversion to laparotomy. In the first converted case (patient #1), using a 0° camera, the dissection was difficult due to a post-stenotic dilatation of the coeliac branches, and the operator preferred a laparotomy to achieve the release of the CA (operating time: 240 min; hospital stay: 14 days). After this case, it was decided to change to a 30° camera. In the second case (patient #4), visual inspection indicated incomplete decompression of the CA despite complete section of the ligament. A pressure line with a needle was inserted through a 10-mm trocar. The needle was placed successively in the supracoeliac aorta and the post-stenotic dilated segment of the coeliac trunk. The gradient of systolic pressure was 30 mmHg and a minilaparotomy was conducted to perform an aorto-hepatic bypass (200 min, 7-day hospital stay). The four remaining cases with retrograde dissection were uneventful; the median operating time was 70 min (interquartile range: 57.5–82.5 min). When using antegrade dissection, no conversion occurred among the five cases, and the median operating time was 80 min (interquartile range: 70–160 min). The supervision of a general surgeon experienced in laparoscopic hiatal surgery was required for the first two cases. Return to food and hospital discharge occurred on the first and third postoperative days, respectively, in the non-converted cases.

Follow-up and outcomes. There was no postoperative death among the 11 patients and no patient was lost to follow-up. The mean follow-up duration was 35 ± 23 months (range: 12–78 months). Symptoms improved immediately in 10/11 patients (Table 1), in which the post-surgical US exam or the CT angiogram showed no residual stenosis in nine cases and a patent aorto-hepatic bypass in the remaining patient. The patient with persisting symptoms (patient #11) underwent a CT angiogram that showed a 70% residual stenosis. In this case, visual inspection after laparoscopic release did not suspect any residual constriction of the CA. A successful angioplasty of the coeliac trunk 3 months after the surgery did not improve the clinical status. After an extensive work-up, a diagnosis of arsenic intoxication was made. In another patient (patient #5), symptoms reappeared after 1 year. This patient, who was symptom-free at 6 months, refused the 6 month CT angiogram, as well as the colour Doppler ultrasound exam. The CT angiogram performed at the time of symptom recurrence showed thrombosis of the coeliac trunk. Catheterisation of the root of the coeliac trunk through a femoral access failed. As pain was tolerable with meal division, the patient refused a second endovascular procedure through a brachial access.

Discussion

In this study, 11 patients underwent trans-peritoneal laparoscopy for CACS with a median operative time of 80 min and two conversions occurred. Only one patient remained unchanged while the symptoms improved immediately in 10 patients but reappeared in one due to CA occlusion at 12 months.

Since the 1970s, detractors have doubted the existence of CACS,[11] maintaining that single-vessel chronic gastrointestinal ischaemia (CGI) was not conceivable because at least two of the three main mesenteric arteries would have to be diseased before a disturbance in the abundant collateral circulation would be noted,[12] and that 60% of patients with coeliac trunk stenosis remain asymptomatic.[13] In the 1980s, Reilly et al.[14] were the first to provide long-term data of the operative repair of CACS. In their study, 44 of 51 patients (86%) were available for late follow-up (mean 9 years) and 32% showed unchanged symptoms after treatment. They found that, in the 18 patients with late follow-up arteriograms, the CA was widely patent in 70% of asymptomatic patients, but stenosed or

Table 1
Patient characteristics, procedure details and outcomes: Antegrade: antegrade laparoscopic dissection of the coeliac trunk; Retrograde: retrograde laparoscopic dissection of the coeliac trunk; M: Male; F: Female; WL: Weight Loss; DUS: Doppler Color UltraSound; CTA: Computed Tomography Angiography. SMA and IMA: Superior and inferior Mesenteric Arteries.

Patients	Sex/Age	BMI	Clinical status	Associated arterial anomalies	Operative duration (minutes)	Technique	Conversion (open surg)	Follow-up (months)	Postoperative symptoms	Postoperative exams
1	M/75	24	Pain		240	Retrograde	Yes (difficult dissection)	78	Pain free	No stenosis (DUS)
2	F/48	21.4	Pain		165	Antegrade	No	67	Pain free	No stenosis (DUS)
3	F/42	21.3	Pain + WL		50	Retrograde	No	46	Pain free	No stenosis (DUS)
4	F/53	15	Pain + WL	Occluded SMA	200	Retrograde	Aorto-hepatic bypass	44	Pain free	Patent bypass (DUS)
5	F/28	18.9	Pain + WL		160	Antegrade	No	44	Recurrent pain At 12 months	Thrombosis (CTA)
6	M/55	18.5	pain + WL	Aortitis Occluded IMA	80	Antegrade	No	25	Pain free	No stenosis (CTA)
7	F/32	19	Pain + WL		60	Retrograde	No	24	Pain free	No stenosis (DUS)
8	F/52	21	Pain + WL		80	Retrograde	No	18	Pain free	No stenosis (DUS)
9	F/64	21.9	Pain + WL		90	Retrograde	No	18	Pain improved	No stenosis (DUS)
10	M/43	24.8	Pain		70	Antegrade	No	12	Pain free	No stenosis (DUS)
11	F/63	26.5	Pain + WL		60	Antegrade	No	12	Unchanged pain	70% stenosis (CTA)

occluded in 75% of symptomatic patients. The authors concluded that persistent clinical improvement in patients with symptomatic CA compression could be achieved by an operative technique that ensures CA patency. They also proposed negative criteria to exclude specific candidates from treatment. Indeed, they observed a negative correlation with clinical improvement in those patients having an atypical pain pattern, with periods of remission, history of psychiatric disorder or alcohol abuse, age older than 60 years and weight loss of less than 9 kg. In our experience, the case of patient #11 who was actually suffering from arsenic poisoning confirms this observation. Until recently, the preoperative work-up lacked an objective exam to provide evidence that one isolated CA stenosis can produce CGI. Currently, gastrointestinal tonometry is the only established technique for detecting gastrointestinal mucosal ischaemia. Mensink et al.[15] demonstrated that a prolonged (24 h) gastric and jejunal tonometry test was accurate in detecting CGI with a sensitivity of 77% and a specificity of 94%. However, this test remains an invasive technique that requires a 24 h hospital stay. Moreover, mucosal ischaemia can often be present for short periods, that is, after exercise or a meal, and fully reversible at other times. Unfortunately, we did not have this exam available in our institutions.

Since the 1990s, laparoscopy has been proposed as an alternative to the laparotomy for the treatment of CACS. Comparing laparoscopy to open surgery, Tulloch et al.[10] have reported significantly shorter times to feeding and lengths of hospitalisation with the laparoscopic approach. Table 2 lists series citing $\geq$10 patients undergoing laparoscopic release. The conversion rate to open surgery varied between 13% and 27%, and the main reason for conversion was bleeding. In Roseborough's experience,[8] the four converted cases were due to direct injuries during the dissection.

In our series, the antegrade approach seemed safer and the help of a second operator experienced in hiatal hernia dissection especially at the beginning of experience together with a 30° camera proved very useful (Table 1). The main difference between the antegrade and the retrograde dissection was extensive section of the diaphragmatic crus, with the former technique resulting in a wider opening of the oesophageal hiatus. As reported by Roseborough et al.,[8] we also observed that complete exposure of the aorta was not necessary, especially with the retrograde approach. Neither approach was confronted with gastro-oesophageal reflux disease (GERD). Mensink et al.[6] observed GERD in 9% after open CACS release, as opposed to 0% in a retroperitoneal endoscopic release, as performed by van Peterson et al.[9] where only the left crus was divided, thereby keeping intact the right branches of the plexus and the right crus. In laparoscopic aortic surgery, most authors prefer a trans-peritoneal approach over a retroperitoneal one that is more challenging due to the smaller working space.[16] All laparoscopic surgeons in this series had early experience in both trans-peritoneal and retroperitoneal laparoscopic aortic surgery, but both chose the trans-peritoneal approach to be able to perform CA reconstruction in case of incomplete release.

Reilly et al.[14] observed that decompression alone compared with decompression with revascularisation, that is, dilatation or reconstruction, improved symptom relief from 53% (8 of 15 patients) to 76% (22 of 29 patients). Grotemeyer et al.[17] treated a series of 18 patients with open surgery; he reconstructed the blood flow in the

Table 2
Series $\geq$10 patients of laparoscopic release of the CACS. PTA: Percutaneous Transluminal Angioplasty.

Author/year	Patients	Mean operative time (minutes)	Conversion to open surgery	Peroperativ adjunct proceduree	Postoperative adjunct procedure	Follow-up (months)	Patients improved or free from symptoms rates
Baccari (7)/2009	16	90 (35–180)	2 (13%)	0	2 PTA, 2 stents	28	16/16 (100%)
Roseborough(8)/2009	15	189 (96–395)	4 (27%)	1 PTA 1 patch 1 bypass	5 PTA, 3 stents 1 bypass	44	14/15 (93%)
Van Petersen (9)/2009	46	130 (72–272)	1 (2%)	0	6 PTA, 3 stents	20	41/46 (89%)
Tulloch (10)/2010	10	220 (160–280) in the non-converted	2 (20%)	0	3 PTA, 2 stents in the non-converted	14	7/8 (88% in the non-converted)
Present study/2011	11	114 (50–240)	2 (18%)	1 bypass	1 PTA, 0 stent	35	9/11 (81%)

coeliac trunk in nine patients and observed that this contributed to an uneventful postoperative course and long-term success.

In our series, patient #4 had a suspected persistent stenosis of the CACS after release of the MAL that was documented by the results of the pressure measurements. In this case, after laparoscopic dissection of the hepatic artery and exposure of the aorta, an aorto-hepatic bypass was achieved through a 10-cm mini-laparotomy. This case raises the concern of perioperative assessment of the quality of the CACS release. Incomplete release with residual stenosis of the CACS that often requires a second endovascular procedure within 3 months postoperatively must be distinguished from a late restenosis, which can be treated by PTA.[7–10] Duplex sonography is recommended in case of suspicion of incomplete release of the MAL. The use of ultrasound scanning to confirm the adequate restoration of flow was first proposed by Roayaie et al.,[18] but it is arguable whether general anaesthesia with muscle relaxation makes it possible to assess respiratory-dependent flow changes. For this reason, some authors prefer systematic digital subtraction angiography during the intervention or on the day after surgery. Using angiography 1 day post surgery, van Petersen et al.[9] found persistent significant stenosis in 10/44 patients and six patients therefore underwent PTA. Our policy was to restrict angiography to those cases where CT angiogram findings showed coeliac trunk stenosis/occlusion confirming persistent or recurrent symptoms. These patients might benefit from the additional use of gastric tonometry. Mensink et al.[6] showed that repeated tonometry after treatment improved in 100% of patients free of symptoms, compared with only 25% in patients with persistent post-interventional complaints. In this series, the use of postoperative gastric tonometry probably would have avoided an unnecessary percutaneous transluminal angioplasty (PTA) in patient #11.

Conclusions

This study showed that CACS can be successfully treated using a trans-peritoneal laparoscopic technique. Initial experience using antegrade dissection, with the assistance of a surgeon experienced in hiatal surgery and a 30° camera was of great help in this series. Endovascular procedures should be reserved for symptomatic patients with incomplete release.

Conflict of Interest

None declared.

Funding

This study received no external funding.

References

1 Lipshutz B. A composite study of the celiac axis artery. *Ann Surg* 1917;**65**:159–69.
2 Harjola PT. A rare obstruction of the celiac artery. Report of a case. *Ann Chir Gynaecol Fenn* 1963;**52**:547–50.
3 Dunbar JD, Molnar W, Beman FF, Marable SA. Compression of the celiac trunk and abdominal angina. *Am J Roentgenol Radium Ther Nucl Med* 1965;**95**:731–44.
4 Noorani A, Walsh SR, Cooper DG, Varty K. Entrapment syndromes. *Eur J Vasc Endovasc Surg* 2009;**37**:213–20.
5 van Noord D, Kuipers EJ, Mensink PB. Single vessel abdominal arterial disease. *Best Pract Res Clin Gastroenterol* 2009;**23**:49–60.
6 Mensink PB, van Petersen AS, Kolkman JJ, Otte JA, Huisman AB, Geelkerken RH. Gastric exercise tonometry: the key investigation in patients with suspected celiac artery compression syndrome. *J Vasc Surg* 2006;**44**:277–81.
7 Baccari P, Civilini E, Dordoni L, Melissano G, Nicoletti R, Chiesa R. Celiac artery compression syndrome managed by laparoscopy. *J Vasc Surg* 2009;**50**:134–9.
8 Roseborough GS. Laparoscopic management of celiac artery compression syndrome. *J Vasc Surg* 2009;**50**:124–33.
9 van Petersen AS, Vriens BH, Huisman AB, Kolkman JJ, Geelkerken RH. Retroperitoneal endoscopic release in the management of celiac artery compression syndrome. *J Vasc Surg* 2009;**50**:140–7.
10 Tulloch AW, Jimenez JC, Lawrence PF, Dutson EP, Moore WS, Rigberg DA, et al. Laparoscopic versus open celiac ganglionectomy in patients with median arcuate ligament syndrome. *J Vasc Surg* 2010;**52**:1283–9.
11 Szilagyi DE, Rian RL, Elliott JP, Smith RF. The celiac artery compression syndrome: does it exist? *Surgery* 1972;**7**:849–63.
12 Mikkelsen WP. Intestinal angina: its surgical significance. *Am J Surg* 1957;**94**:262–9.
13 Choghari C, Bosschaert T, Barroy JP. Dunbar's syndrome. *Acta Chir Belg* 1994;**94**:207–9.
14 Reilly LM, Ammar AD, Stoney RJ, Ehrenfeld WK. Late results following operative repair for celiac artery compression syndrome. *J Vasc Surg* 1985;**2**:79–91.
15 Mensink PB, Geelkerken RH, Huisman AB, Kuipers EJ, Kolkman JJ. Twenty-four hour tonometry in patients suspected of chronic gastrointestinal ischemia. *Dig Dis Sci* 2008;**53**:133–9.
16 Cau J, Ricco JB, Corpataux JM. Laparoscopic aortic surgery: techniques and results. *J Vasc Surg* 2008;**48**:37S–44S. discussion 45S.
17 Grotemeyer D, Duran M, Iskandar F, Blondin D, Nguyen K, Sandmann W. Median arcuate ligament syndrome: vascular surgical therapy and follow-up of 18 patients. *Langenbecks Arch Surg* 2009;**394**:1085–92.
18 Roayaie S, Jossart G, Gitlitz D, Lamparello P, Hollier L, Gagner M. Laparoscopic release of celiac artery compression syndrome facilitated by laparoscopic ultrasound scanning to confirm restoration of flow. *J Vasc Surg* 2000;**32**:814–7.